# §36. Temporal Evolutions of Electron Density Profiles and its Transport Aspects on LHD

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The particle confinement characteristic of NBI heated plasma of LHD was studied from the comparison between strong density clumping shot (shot 3560) and weak one (shot 6616) 1). Both shots are heated by same scheme and power, but magnetic configurations (magnetic axis (Rax) and toroidal magnetic field (Bt)) are different. Figures 1 (a) and (b) show strong and weak density clumping shots respectively. For the quantitative study, the correlation between grad $n_e$ /$n_e$ and ? /$n_e$ during the shots was examined. Here, ? is the particle flux, and it can be calculated from the integration form of the particle balanced equations described by the following.

$$\Gamma(r) = \int_0^r r(S - \frac{\partial n_e}{\partial t})dr,$$

where S is the source rate and S consists of beam source ($S_{NBI}$) and wall source ($S_{wall}$). In fig. 2, the slope of the linear line, which can be shown by the following equation,

$$\Gamma / n_e = -D\nabla n_e / n_e + V,$$

indicates the diffusion coefficient (D) and the value on the y-axis indicates the convective velocity (V) .

Data at ρ=0.7 were used, because grad $n_e$ / $n_e$ changes widely in both shots at that radius. As shown in fig. 2, data of shot 3560 (strong density clumping shot) are plotted in the same data region of shot 6616 (weak density clumping shot) at the beginning of the discharge, but, transit to the different D, V line from that of shot 6616 (weak density clumping shot). In both discharges, during the time period from t = 0.5 to t = 0.6 sec, electron temperature and its gradient at ρ = 0.7 increased rapidly (stronger in shot 3560 (strong density clumping shot) ). This could induce outward flux, which is predicted by the neoclassical theory. In this analysis, V is negligible in shot 6616. The better confinement of shot 6616 (weak density clumping shot) can be characterized by smaller V rather than smaller D. Although the analysis is sensitive to the determination of $S_{wall}$, shot 3560 (strong clumping shot) needs outward convective velocity (about 0.5 m/sec) to explain the change of density profiles, even if $S_{wall}$ is zero.

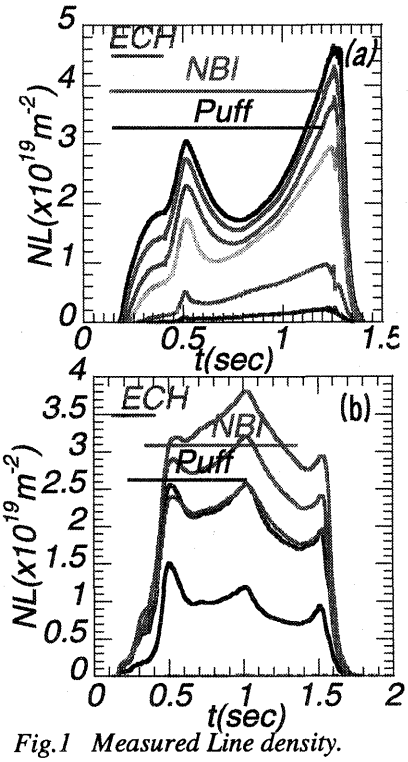


*Fig.1 Measured Line density.*
*(a) Shot 3560 Rax=3.75m,Bt=1.5T*
*(b) Shot 6616 Rax=3.6m,Bt=2.5T*
*Both are Hydrogen Plasama*

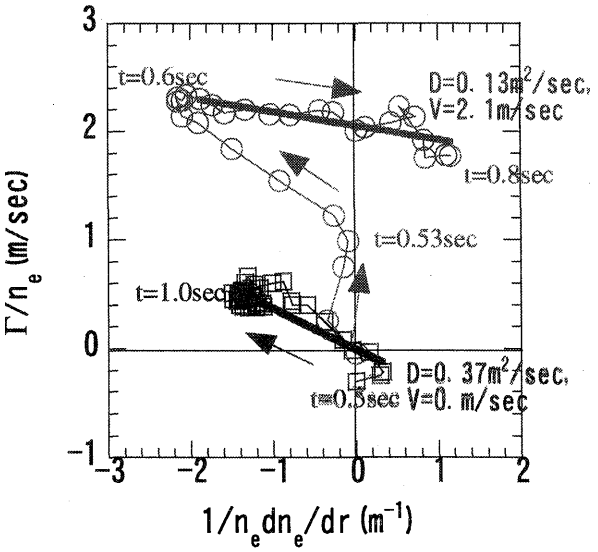


*Fig. 2 $1/n_e\, dn_e dr$-$\Gamma/n_e$ plots*
*Circles indicate shot 3560 (Rax=3.75m,Bt=1.5T) at ρ=0.7 from t=0.5 to 0.8sec*
*Squares indicate shot 6616 (Rax=3.6m,Bt=2.5T) at ρ=0.7 from t=0.5 to 1.0sec*
*Data points are every 10 msec.*
*Positive Γ indicates outward flux.*

References

1) K.Tanaka, et al, proc. EPS 99 Maastricht